SNS COLLEGE OF ALLIED HEALTH SCIENCES
SNS Kalvi Nagar, Coimbatore - 35
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DEPARTMENT : PHYSICIAN ASSISTANT

COURSE NAME : NEUROLOGY

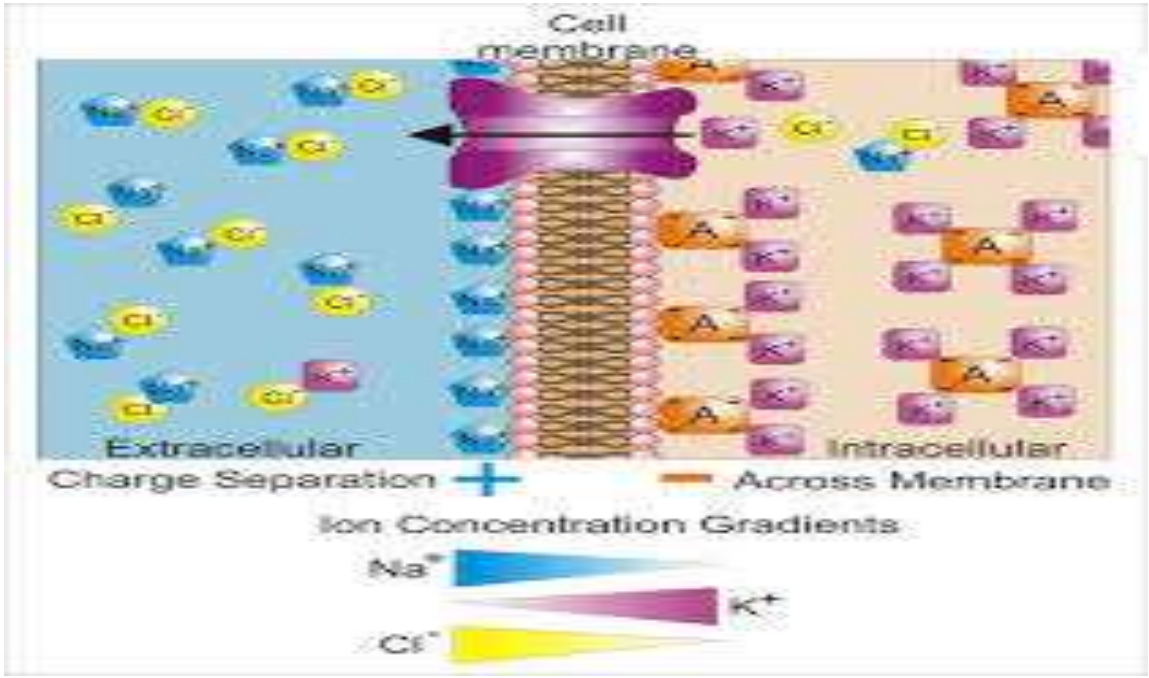
UNIT : NERVOUS SYSTEM

TOPIC : CELL MEMBRANE - ACTION POTENTIAL AND PROPERTIES OF NERVE FIBERS

ACTION POTENTIAL

- An action potential is a rapid sequence of changes in the voltage across a membrane. The membrane voltage, or potential, is determined at any time by the relative ratio of ions, extracellular to intracellular, and the permeability of each ion.

- The action potential allows for the transmission of information over long distances within the nervous system, enabling processes such as sensory perception, motor control, and cognitive functions.


Cell membrane
Extracellular
Intracellular
Charge Separation
Across Membrane
Ion Concentration Gradients
Na+
K+
Cl-

Threshold:

- The threshold is the membrane potential at which an action potential is initiated.
- It is typically around -55 millivolts (mV) in neurons.
- When the membrane potential reaches threshold, voltage-gated sodium channels open, initiating depolarization.

Depolarization:

- Depolarization is the rapid change in membrane potential from negative to positive.
- Voltage-gated sodium channels open in response to depolarization, allowing sodium ions (Na+) to rush into the cell, causing the membrane potential to become more positive.

- This positive feedback loop further activates neighboring voltage-gated sodium channels, resulting in the rapid upstroke of the action potential.

Repolarization:

- Repolarization is the restoration of the membrane potential to its resting state after depolarization.
- Voltage-gated potassium channels open, allowing potassium ions (K+) to leave the cell, leading to an efflux of positive charge and the restoration of the negative membrane potential.

- As the membrane potential becomes more negative, voltage-gated sodium channels inactivate, preventing further sodium influx.

Hyperpolarization:

- Hyperpolarization occurs when the membrane potential becomes more negative than the resting membrane potential.
- It is often caused by the prolonged opening of potassium channels, resulting in an overshoot of the resting membrane potential.
- Hyperpolarization helps reset the membrane potential and ensures that the neuron is refractory to further stimulation for a brief period.

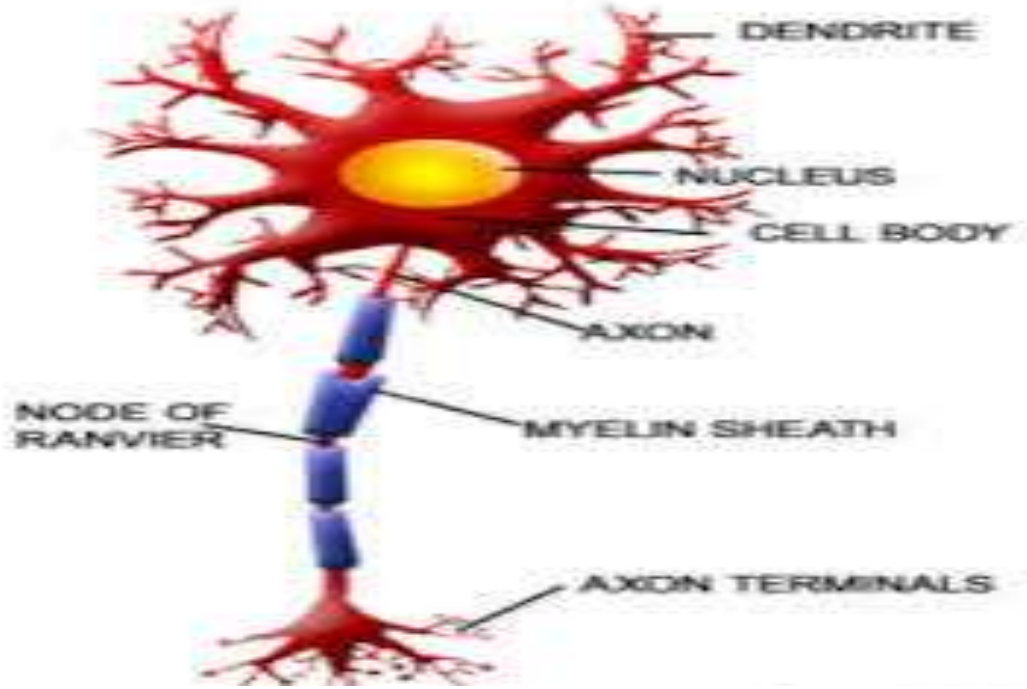
Refractory Period:

- The refractory period is the period following an action potential during which the neuron is temporarily unable to generate another action potential.
- It consists of an absolute refractory period, during which no stimulus can evoke an action potential, and a relative refractory period, during which a stronger stimulus is required to generate an action potential.

PROPERTIES OF NERVE FIBERS

Myelination:

- Myelination refers to the insulation of nerve fibers by myelin sheaths, which are produced by oligodendrocytes in the central nervous system (CNS) and Schwann cells in the peripheral nervous system (PNS).


DENDRITE
NUCLEUS
CELL BODY
AXON
NODE OF RANVIER
MYELIN SHEATH
AXON TERMINALS

- Myelinated fibers conduct nerve impulses faster than unmyelinated fibers due to saltatory conduction, where the action potential jumps from one node of Ranvier to the next.

- Myelination also conserves energy by reducing the number of ion channels needed for action potential propagation.

Conduction Velocity:

- The conduction velocity of a nerve fiber is the speed at which an action potential propagates along the fiber.
- Conduction velocity is influenced by fiber diameter and myelination.
- Myelinated fibers conduct impulses faster than unmyelinated fibers of the same diameter due to saltatory conduction.

Classification:

- Nerve fibers are classified based on diameter, myelination, and conduction velocity into categories such as A, B, and C fibers.
- A fibers are large, myelinated fibers that conduct impulses rapidly and are responsible for sharp, localized sensations.

- B fibers are medium-sized, lightly myelinated fibers that conduct impulses moderately fast and are involved in autonomic functions.

- C fibers are small, unmyelinated fibers that conduct impulses slowly and are responsible for dull, diffuse sensations.

Propagation:

- Action potentials propagate along nerve fibers through the sequential opening and closing of voltage-gated ion channels.
- In myelinated fibers, action potentials jump from one node of Ranvier to the next, resulting in rapid and efficient conduction.
- In unmyelinated fibers, action potentials spread continuously along the membrane, leading to slower conduction velocities.

ASSESSMENT

- What is Action Potential ?
- What is Classification of Nerve fibers ?